

APEX MICROTECHNOLOGY CORPORATION
RELIABILITY PREDICTION
PA03

by

Granger Scofield

Date of prediction: 15-Mar-01

This reliability prediction is based on MIL-HDBK-217F,
December 2, 1991 including Notice 2, February 28, 1995.

Conditions of this prediction are as follows:

| | |
|------------------------------|---------------|
| Hybrid quality level is | Commercial |
| Environment is Gf | Ground, Fixed |
| Case temperature is | 45 C |
| Internal Power Dissipation = | 220 W |
| Supply voltage is +/- | 15 V |
| An AC signal is applied. | |
| Product introduction date: | 15-Aug-85 |

The results of this prediction are:

4.18 failures per million hours; or,
MTBF=239 thousand hours.

Transistors, Low Frequency, Bipolar:

$$L_p = L_b * P_{iT} * P_{iR} * P_{iS}$$

| | | | | | | |
|-----------|----------------|-------------|-------------|-------------|----------------|----------|
| Q8,33 | | Volts = 40 | Watts = 1.2 | Tj = 175 | 'K/W= 125 | |
| Usage: | Vstress = 0.65 | Vpwr = 0.65 | Ic = 0.025 | Vs = 0.0163 | Power = 0.0163 | |
| Lb | PiT | PiR | PiS | Nc | Tj = 47.031 | |
| 0.00074 | 1.629633 | 1.0698 | 0.0473 | 2 | | 0.000122 |
| | | | | | | |
| Q1 | | Volts = 40 | Watts = 1.2 | Tj = 175 | 'K/W= 125 | |
| Usage: | Vstress = 1.3 | Vpwr = 1.3 | Ic = 1E-05 | Vs = 0.0325 | Power = 1E-05 | |
| Lb | PiT | PiR | PiS | Nc | Tj = 45.002 | |
| 0.00074 | 1.562356 | 1.0698 | 0.0498 | 1 | | 6.16E-05 |
| | | | | | | |
| Q38,40 | | Volts = 60 | Watts = 1.2 | Tj = 175 | 'K/W= 125 | |
| Usage: | Vstress = 2 | Vpwr = 2 | Ic = 1E-05 | Vs = 0.0333 | Power = 2E-05 | |
| Lb | PiT | PiR | PiS | Nc | Tj = 45.003 | |
| 0.00074 | 1.562385 | 1.0698 | 0.0499 | 2 | | 0.000123 |
| | | | | | | |
| Q16,24 | | Volts = 350 | Watts = 5 | Tj = 200 | 'K/W= 35 | |
| Usage: | Vstress = 26 | Vpwr = 11 | Ic = 0.025 | Vs = 0.0743 | Power = 0.275 | |
| Lb | PiT | PiR | PiS | Nc | Tj = 54.625 | |
| 0.00074 | 1.899253 | 1.8139 | 0.0567 | 1 | | 0.000144 |
| | | | | | | |
| Q30 | | Volts = 120 | Watts = 1.2 | Tj = 200 | 'K/W= 145.83 | |
| Usage: | Vstress = 2.5 | Vpwr = 2.5 | Ic = 1E-05 | Vs = 0.0208 | Power = 3E-05 | |
| Lb | PiT | PiR | PiS | Nc | Tj = 45.004 | |
| 0.00074 | 1.562422 | 1.0698 | 0.048 | 1 | | 5.94E-05 |
| | | | | | | |
| Q7 | | Volts = 140 | Watts = 1.2 | Tj = 200 | 'K/W= 145.83 | |
| Usage: | Vstress = 2.2 | Vpwr = 2.2 | Ic = 1E-05 | Vs = 0.0157 | Power = 2E-05 | |
| Lb | PiT | PiR | PiS | Nc | Tj = 45.003 | |
| 0.00074 | 1.562408 | 1.0698 | 0.0472 | 1 | | 5.84E-05 |
| | | | | | | |
| Q34 | | Volts = 140 | Watts = 1.2 | Tj = 200 | 'K/W= 145.83 | |
| Usage: | Vstress = 1.3 | Vpwr = 1.3 | Ic = 1E-05 | Vs = 0.0093 | Power = 1E-05 | |
| Lb | PiT | PiR | PiS | Nc | Tj = 45.002 | |
| 0.00074 | 1.562365 | 1.0698 | 0.0463 | 1 | | 5.73E-05 |
| | | | | | | |
| Q19,23,34 | | Volts = 140 | Watts = 1.2 | Tj = 200 | 'K/W= 145.83 | |
| Usage: | Vstress = 1.3 | Vpwr = 1.3 | Ic = 0.01 | Vs = 0.0093 | Power = 0.013 | |
| Lb | PiT | PiR | PiS | Nc | Tj = 46.896 | |
| 0.00074 | 1.625082 | 1.0698 | 0.0463 | 3 | | 0.000179 |

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|------------------------|----------------------------|----------------|----------------|--------------|
| Q9-11,26-28 | Volts = 140 | Watts = 178.6 | Tj = 175 | 'K/W= 0.8399 |
| Usage: Vstress = 23 | Fraction Output Pwr = 1/3 | Vs = 0.1643 | Power = 73.333 | |
| Lb PiT | PiR PiS | Nc Tj = 106.59 | | |
| 0.00074 4.594202 | 6.8108 0.0749 | 6 | | 0.010404 |
| Q13,25 | Volts = 120 | Watts = 59.5 | Tj = 150 | 'K/W= 2.1008 |
| Usage: Vstress = 23.5 | Fraction Output Pwr = 1/15 | Vs = 0.1958 | Power = 14.667 | |
| Lb PiT | PiR PiS | Nc Tj = 75.812 | | |
| 0.00074 2.810589 | 4.5349 0.0826 | 2 | | 0.001558 |
| Q5 | Volts = 300 | Watts = 1.15 | Tj = 150 | 'K/W= 108.7 |
| Usage: Vstress = 14.7 | Vpwr = 9.7 Ic = 0.0005 | Vs = 0.049 | Power = 0.0049 | |
| Lb PiT | PiR PiS | Nc Tj = 45.527 | | |
| 0.00074 1.579587 | 1.0531 0.0524 | 1 | | 6.45E-05 |
| Q6 | Volts = 300 | Watts = 1.15 | Tj = 150 | 'K/W= 108.7 |
| Usage: Vstress = 27.8 | Vpwr = 12.8 Ic = 0.01 | Vs = 0.0927 | Power = 0.128 | |
| Lb PiT | PiR PiS | Nc Tj = 58.913 | | |
| 0.00074 2.064363 | 1.0531 0.06 | 1 | | 9.65E-05 |
| Q14,22 | Volts = 300 | Watts = 1.15 | Tj = 150 | 'K/W= 108.7 |
| Usage: Vstress = 15 | Vpwr = 15 Ic = 1E-05 | Vs = 0.05 | Power = 0.0002 | |
| Lb PiT | PiR PiS | Nc Tj = 45.016 | | |
| 0.00074 1.562836 | 1.0531 0.0525 | 2 | | 0.000128 |
| Q15 | Volts = 300 | Watts = 1.15 | Tj = 150 | 'K/W= 108.7 |
| Usage: Vstress = 25.95 | Vpwr = 10.95 Ic = 0.005 | Vs = 0.0865 | Power = 0.0548 | |
| Lb PiT | PiR PiS | Nc Tj = 50.951 | | |
| 0.00074 1.765234 | 1.0531 0.0588 | 1 | | 8.09E-05 |
| Q17,18 | Volts = 300 | Watts = 1.15 | Tj = 150 | 'K/W= 108.7 |
| Usage: Vstress = 9 | Vpwr = 9 Ic = 0.0022 | Vs = 0.03 | Power = 0.0198 | |
| Lb PiT | PiR PiS | Nc Tj = 47.152 | | |
| 0.00074 1.633704 | 1.0531 0.0494 | 2 | | 0.000126 |
| Q31 | Volts = 300 | Watts = 1.15 | Tj = 150 | 'K/W= 108.7 |
| Usage: Vstress = 10.9 | Vpwr = 10.9 Ic = 0.0049 | Vs = 0.0363 | Power = 0.0534 | |
| Lb PiT | PiR PiS | Nc Tj = 50.805 | | |
| 0.00074 1.76006 | 1.0531 0.0504 | 1 | | 6.91E-05 |
| Q29 | Volts = 300 | Watts = 1.15 | Tj = 150 | 'K/W= 108.7 |
| Usage: Vstress = 24 | Vpwr = 12.5 Ic = 0.01 | Vs = 0.08 | Power = 0.125 | |
| Lb PiT | PiR PiS | Nc Tj = 58.587 | | |
| 0.00074 2.051473 | 1.0531 0.0577 | 1 | | 9.22E-05 |

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|---------|----------------|-------------|--------------|-------------|----------------|----------|
| Q35 | | Volts = 300 | Watts = 1.15 | Tj = 150 | 'K/W= 108.7 | |
| Usage: | Vstress = 21.5 | Vpwr = 12.5 | Ic = 1E-05 | Vs = 0.0717 | Power = 0.0001 | |
| Lb | PiT | PIR | PiS | Nc | Tj = 45.014 | |
| 0.00074 | 1.562747 | 1.0531 | 0.0562 | 1 | | 6.84E-05 |
| | | | | | | |
| Q36,37 | | Volts = 300 | Watts = 1.15 | Tj = 150 | 'K/W= 108.7 | |
| Usage: | Vstress = 24.4 | Vpwr = 24.4 | Ic = 0.0033 | Vs = 0.0813 | Power = 0.0805 | |
| Lb | PiT | PIR | PiS | Nc | Tj = 53.752 | |
| 0.00074 | 1.866798 | 1.0531 | 0.0579 | 2 | | 0.000168 |
| | | | | | | |
| Q2,3 | | Volts = 20 | Watts = 0.38 | Tj = 150 | 'K/W= 328.95 | |
| Usage: | Vstress = 1.34 | Vpwr = 1.34 | Ic = 0.0022 | Vs = 0.067 | Power = 0.0029 | |
| Lb | PiT | PIR | PiS | Nc | Tj = 45.97 | |
| 0.00074 | 1.5942 | 0.6991 | 0.0554 | 2 | | 9.14E-05 |
| | | | | | | |
| Q12 | | Volts = 20 | Watts = 0.38 | Tj = 150 | 'K/W= 328.95 | |
| Usage: | Vstress = 0.6 | Vpwr = 0.6 | Ic = 0.005 | Vs = 0.03 | Power = 0.003 | |
| Lb | PiT | PIR | PiS | Nc | Tj = 45.987 | |
| 0.00074 | 1.594766 | 0.6991 | 0.0494 | 1 | | 4.07E-05 |

Transistors, Low Frequency, Si JFET: Lb = 0.0045
 Lp = Lb * PiT

| | | | | | | |
|--------|----------|------------|--------------|----------|----------------|----------|
| Q20A,B | | Volts = 25 | Watts = 0.55 | Tj = 150 | 'K/W= 227.27 | |
| Usage: | | Vpwr = 4 | Id = 0.0022 | | Power = 0.0088 | |
| Lb | PiT | | | Nc | Tj = 47 | |
| 0.0045 | 1.559097 | | | 2 | | 0.014032 |

Capacitors, ceramic general purpose type CK:

Lp = Lb * PiT * PiC * PiV Lb = 0.00099

| | | | | | | |
|---------|---------------|-------------|-----------|-----------|----|----------|
| C6 | | Volts = 100 | pF = 2200 | S = 0.025 | | |
| Usage: | Vstress = 2.5 | | | | Nc | |
| Lb | PiT | PiC | Pi V | | | |
| 0.00099 | 2.356629 | 0.31 | 1.0001 | | 1 | 0.000722 |

| | | | | | | |
|---------|-------------|------------|-----------|----------|----|----------|
| C1 | | Volts = 25 | pF = 3300 | S = 0.08 | | |
| Usage: | Vstress = 2 | | | | Nc | |
| Lb | PiT | PiC | Pi V | | | |
| 0.00099 | 2.356629 | 0.321 | 1.0024 | | 1 | 0.000751 |

| | | | | | | |
|---------|---------------|-------------|----------|-----------|----|----------|
| C5 | | Volts = 200 | pF = 150 | S = 0.023 | | |
| Usage: | Vstress = 4.6 | | | | Nc | |
| Lb | PiT | PiC | Pi V | | | |
| 0.00099 | 2.356629 | 0.243 | 1.0001 | | 1 | 0.000567 |

C9
 Usage: Vstress = 0.65 S = 0.0065
 Lb PiT PiC Pi V Nc
 0.00099 2.356629 0.368 1 1 0.000859

C4
 Usage: Vstress = 27.4 S = 0.137
 Lb PiT PiC Pi V Nc
 0.00099 2.356629 0.269 1.0119 1 0.000636

C8
 Usage: Vstress = 2.5 S = 0.05
 Lb PiT PiC Pi V Nc
 0.00099 2.356629 0.395 1.0006 1 0.000922

C2,7
 Usage: Vstress = 0.65 S = 0.026
 Lb PiT PiC Pi V Nc
 0.00099 2.356629 0.408 1.0001 2 0.001903

Diodes, Power Rectifier, Fast Recovery, Lb = 0.025

D2,3
 Usage: Volts = 150 Watts = 4.29 Tj = 175 'K/W= 34.965
 Volts = 25 Ic = 0.001 Vs = 0.1667 Power = 0.0007
 Lb PiT PiS PiC Nc Tj = 45.023
 0.025 1.921396 0.054 1 2 0.005188

Diodes, Zener, Lb = 0.002

D1,4
 Usage: Volts = 3.1 Watts = 2.5 Tj = 175 'K/W= 60
 Ic = 0.003 Power = 0.0093
 Lb PiT PiS PiC Nc Tj = 45.558
 0.002 1.517214 1 2 2 0.012138

Sum of all components 0.051511

Hybrid microcircuit:

$Lp = \sum Lc * (1 + .2 * PiE) * PiF * PiQ * PiL$
 0.051511 1.4 5.8 10 1

Total failures per million hours = 4.1827
 Mean time between failures = 239082